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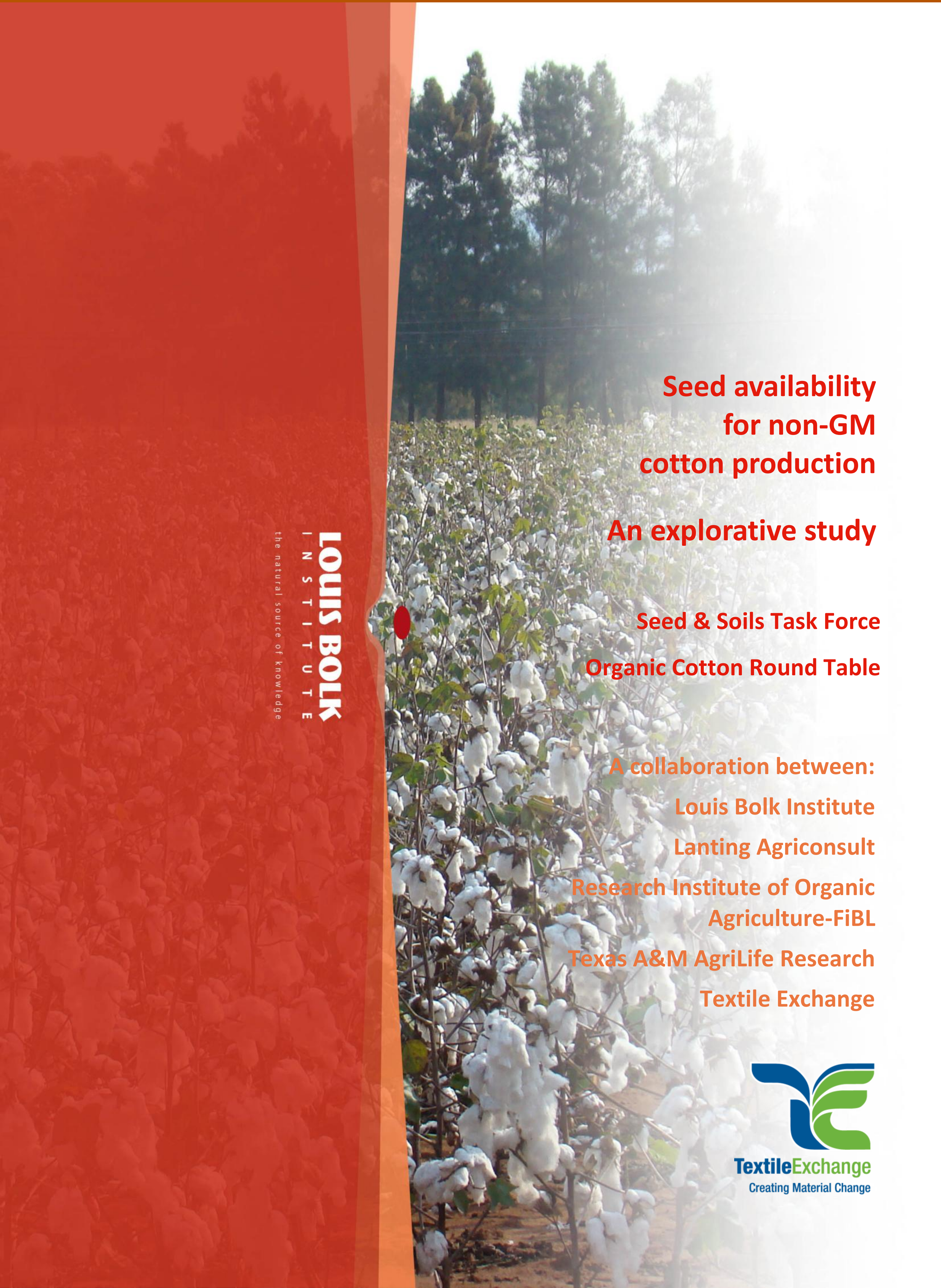

LOUIS BOLK INSTITUTE
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Seed availability for non-GM cotton production

An explorative study

Seed & Soils Task Force

Organic Cotton Round Table

A collaboration between:

Louis Bolk Institute

Lanting Agriconsult

Research Institute of Organic Agriculture-FiBL

Texas A&M AgriLife Research

Textile Exchange

TextileExchange
Creating Material Change

This explorative study is an inventory: A first assessment of the problems of accessing organic seed and the contamination of organic cotton seed with genetic modification (GM) in the field. Outcomes of the inventory lead to hypotheses to be tested in further regional workshops. This inventory is an initial step in developing a master plan for safeguarding the availability of organic cotton seed.

Approximately 81% of respondents overall, including 90% of organic farmers who responded, are of the opinion that organic cotton seed is difficult to access. In countries where GM cotton is predominant (the USA, India, China and Burkina Faso) close to 90% of respondents feel it is “difficult” to “impossible” to access organic cotton seed. Accessing organic cotton seed is considered problematic even in countries where GM cotton is not grown.

Close to 96% of respondents believe that seed multiplication programmes are important to ensure the availability of **organic** cotton seed.

Next to seed multiplication, breeding programmes to better adapt varieties to organic and low-input growing conditions were a priority. It is recommended that workshops be implemented in India, China and West-Africa to develop detailed seed strategies for those areas.

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Seed availability for non-GM Cotton production - An explorative study
Seed & Soils Task Force, OCRT, Textile Exchange

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Cover picture: Organic cotton field in Africa
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Acronyms

Bt	Bacillus thuringiensis
CICR	Central Institute Cotton Research
CIRAD	Centre Internationale de la Recherche Agronomique pour la Développement
CMT	Cut, Make and Trim
CRS	Catholic Relief Services
FiBL	Forschungsinstitut für biologischen Landbau, Research Institute of Organic Agriculture
GM	Genetically Modified
HYV	High Yielding Variety
INERA	Institute of Environmental and Agricultural Research
INR	Indian Rupee
LBI	Louis Bolk Institute
NGDO	Non-Governmental Development Organization
OCRT	Organic Cotton Round Table
SAU	State Agricultural University
SC	Seed Cotton
TE	Textile Exchange
UNPCB	Union Nationale des Producteurs de Coton de Burkina Faso
USDA	United States Department of Agriculture
WU	Wageningen University

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All the members of the Seed & Soils Task Force have a long term association with the cotton sector.

Mans Lanting and Edwin Nuijten, breeding researcher (LBI, Driebergen-NL), have set up the inquiry and analysed the results. The report is written by Mans Lanting, Edwin Nuijten, and Edith Lammerts van Bueren.

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Edith Lammerts van Bueren

Chair, Seed & Soils Task Force

March 2015

Executive Summary

Certified organic cotton production sits at just under 1% of global cotton cultivation. The five biggest producers of organic cotton are: India (>70%), China, Turkey, USA, and Tanzania. Other production areas include West, East and North Africa, Latin America, Egypt, Israel and Central Asia (Kyrgyzstan and Tajikistan).

By 2013, 74% of the global (conventional) cotton area (23.9 million ha) was cultivated with GM cotton in 15 countries in five continents (ISAAA report 2013). This includes China, India, Pakistan, Myanmar, USA, Mexico, Costa Rica, Colombia, Paraguay, Argentina, Brazil, Australia, South Africa, and Burkina Faso.

The objective of the inventory presented in this report is to provide a bird's eye view of worldwide and region-specific organic cotton seed availability, contamination issues, trends in cotton production, challenges in cotton production and opinions on what the "ideal" cotton is. It will also explore thoughts on what kind of cotton should be grown in 2025 and what sort of seed programmes should be implemented in which regions to ensure integrity and growth of organic cotton production.

An internet based questionnaire was sent out to approximately 900 stakeholders. The respondents (10% in total) were well spread throughout the textile value chain and across all major cotton producing regions.

The number of respondents per continent was, however, too low to arrive at solid and statistically sound conclusions. The report formulates hypotheses that should be checked against reality in regional workshops.

Organic cotton seed was considered difficult to access according to 81% of the respondents who considered themselves able to assess this issue. In areas where GM cotton is grown, 90% of respondents faced problems accessing organic cotton seed. In areas where only conventional cotton is grown, 40% of respondents found it difficult to access organic cotton seed.

Contamination problems with GM cotton were experienced by 50% of respondents. Those producing organic cotton in countries where GM cotton is not yet allowed to grow do not face contamination problems. Turkey and Tanzania are the only major organic cotton producers that do not (yet) face any problems with contamination (concluded from the questionnaire).

Most respondents point at cross pollination as the major cause of contamination. Research, implemented in Burkina Faso and the USA, however, points at seed purchased for late plantings as the major pathway for contamination of organic cotton. Possible pathways are analysed in the report. Ginning factories emerge in the role of guardians of pure organic seed.

Not only organic cotton seed availability is at stake, also the efficiency and profitability in organic cotton value chain needs to be improved. Cotton, as a crop, is under pressure from easier to grow and more profitable alternative crops such as soybean. About 45% of respondents think that cotton area might reduce. It is worrying that these originate from major cotton producing countries like India and the USA. Chinese respondents feel that their cotton area will expand, as do a number of other, presently smaller, cotton producing countries.

Many of the respondents who felt able to describe the ideal cotton thought that the staple length of cotton should increase to "long". Retailers and wholesalers, however, predicted that the market

of t-shirts will drastically increase and these would probably not require much longer staple length than 29mm. The ideal cotton described is a utopian one. It cannot be realised as the criteria given are in conflict. There also appears a mismatch between the diseases and pests that breeders focus on in their breeding programmes and those that were prioritised by respondents as the biggest production constraints. Further priority ranking of breeding/selection criteria will need to be defined in each sub-region.

Almost all respondents (95%) felt it is important to develop seed programmes. Preference was given to non-GM seed multiplication programmes but selection and breeding programmes for organic cotton variety improvement was a close second.

Cotton producers in Tanzania (including the organic cotton initiative “bioRe Tanzania”) are addressing access to better quality, open-pollinated cotton seed with support from the Gatsby Foundation. Turkish farmers seem to have little problem in accessing non-GM cotton seed as the country has banned the use of all GM organisms. It appears that organic cotton growers in the USA are already getting together to resolve their serious problems of accessing non-GM cotton seed. It is therefore recommended to initiate regional workshops most urgently in India, China and West Africa. The goal of such regional workshops should be to define the involved stakeholders, specify the regional specific bottlenecks and opportunities to on the one hand develop seed and breeding programmes to safeguard non-GM seed availability and seed quality, and on the other hand to improve efficiency and profitability of the organic cotton value chain. This will contribute to the future organic cotton integrity.

1 Introduction

The Challenge

Certified organic cotton production sits at just under 1% of global cotton cultivation. The five biggest producers of organic cotton are India (>70%), China, Turkey, the USA, and Tanzania. Other production areas are in West, East and North Africa, Latin America, Egypt, Israel, and Central Asia (Kyrgyzstan and Tajikistan).

According to the ISAAA report by 2013 74% of global cotton area was cultivated with GM cotton (23.9 million ha) in 15 countries in five continents (James, 2013). This includes China, India, Pakistan, Myanmar, USA, Mexico, Costa Rica, Colombia, Paraguay, Argentina, Brazil, Australia, South Africa, and Burkina Faso.

In addition to GM cotton offering insect resistance, new cotton cultivars also contain stacked Bt genes or combinations of Bt genes and herbicide resistance genes. It is clear that, with the rise of Bt cotton production in India (where it accounts for over 95% of production), the USA, China, parts of Latin America, Southern Africa, Burkina Faso and probably the whole of Sub-Saharan Africa, GM cotton is, or will soon be, dominating the market, and organic farmers have, or will have, a problem accessing non-GM seed.

Although, presently, two thirds of the 18 countries that cultivate organic cotton have not yet officially commercialised GM, this might change very soon considering that GM cotton has already spread to all major cotton production regions. Governments of cotton growing countries that have not yet released GM crops are continuously approached by the GM lobby to approve GM cotton. In addition, the illegal exchange of GM cotton across countries cannot be prevented. Besides the problem of access to organic seed, the integrity of organic cotton is also put at risk through contamination of organic cotton with GM cotton.

Background

Textile Exchange (TE), via its Organic Cotton Round Table (OCRT), has conducted a number of workshops to discuss the seed issue in organic cotton production. In 2013, several organic seed production programmes presented their activities at the OCRT session in Istanbul. It was decided to create a Task Force to make an inventory of the challenges in accessing organic cotton seed and to develop a master plan for seed production. This master plan would serve as a guideline for Textile Exchange to target its funds to support organic cotton seed production programmes.

Objectives

The objective of the inventory presented in this report is to provide a bird’s eye view of worldwide and region-specific organic cotton seed availability, contamination issues, trends in cotton production, challenges in cotton production and opinions on what is the “ideal” cotton. It will also explore thoughts on what kind of cotton should be grown in 2025 and what sort of seed programmes should be implemented in which regions to ensure integrity and growth of organic cotton production.

This report presents the results of the inventory and lays the foundation for regional workshops that should provide more accurate and action oriented outcomes.

Methodology

An internet based survey was carried out in order to create an inventory of issues, challenges and opportunities for the organic cotton sector. In doing so, it was anticipated that a broad picture of organic cotton seed availability in all major cotton producing regions would be established.

An internet based survey is not the ideal vehicle to reliably establish availability of organic cotton seed. To overcome this shortcoming, responses from different stakeholder groups within the textile value chain were analysed by specific region to ascertain whether a consistent pattern would emerge. Such consistencies were found in areas where multiple stakeholder groups replied to the questionnaire. The findings of the survey are qualitative in nature and can only be used as a stepping stone for further, more quantitative studies. The results of this survey can be used to determine areas where these quantitative studies need to be conducted.

However, the survey results do give adequate insight to be able to discern issues and emerging trends and to make recommendations for priorities and next steps.

The Survey

The following broad areas were addressed in the questionnaire:

- Information about the respondents and their position in the textile value chain
- Availability of organic, conventional and GM cotton seed
- Contamination of organic cotton with GM cotton
- Whether acreage of organic cotton is increasing or decreasing relative to conventional and GM cotton
- The profitability of cotton growing and whether there is a risk that farmers will shy away from cotton growing
- The main factors that are negatively affecting yields
- The characteristics of an ideal organic cotton variety
- The quality of lint expected to be required in 10 years from now
- Whether or not seed programmes are required

Each stakeholder group received questions addressing these issues from their particular perspective. For example, we asked farmers, breeders and spinners about expected staple length while weavers and retailers were asked about the quality of yarn and the finished products that they expect to sell 10 years from now. All of the replies can be linked to the staple length required.

In total, over 900 stakeholders across all major cotton producing regions and across all levels of the textile value chain received, through TE, a request to fill in the questionnaire.

The Report

The report will follow the sequence of the thematic questions as presented above and will provide a simplified analysis from the perspective of the different stakeholders in the value chain.

2 Results

Profile of Respondents

Table 1: Respondents' position in the textile value chain

Answer Options	Response %
I am a farmer	11.5%
I represent a farmers' group (please discuss with your group and fill in as if you are one farmer)	23.1%
I am NGO staff	21.2%
I am a ginner	13.5%
I am a trader in lint	11.5%
I am a breeder	15.4%
I am a seed company	3.8%
I am an vertically integrated unit (ginning, spinning, weaving, CMT)	11.5%
I am a spinner	5.8%
I am a weaver	0.0%
I am a CMT unit	1.9%
I am a wholesaler of yarn	3.8%
I am a wholesaler of fabric	7.7%
I am a retailer	25.0%

The questionnaire was sent out to approximately 900 stake-holders from TE's database. Some 90 stakeholders responded which is 10%.

Table 1 and Figure 1 show that the respondents are well distributed both globally and throughout the textile value chain. 55% of respondents were either farmers or represented farmers. The remaining 45% represented the post farm value chain with a slight over-representation of the retail sector. This is not surprising as the majority of TE members are retailers.

Looking at the origin of respondents, Europe and the USA were well represented mainly through the retail and trading categories. The largest number of responses was from India. Language barriers might have limited responses from China, Central Asia, South America and West Africa.

The number of respondents was too low to arrive at statistically sound conclusions per region or per stakeholder group. However, the number of respondents is sufficiently large to be able to discern issues and emerging trends.

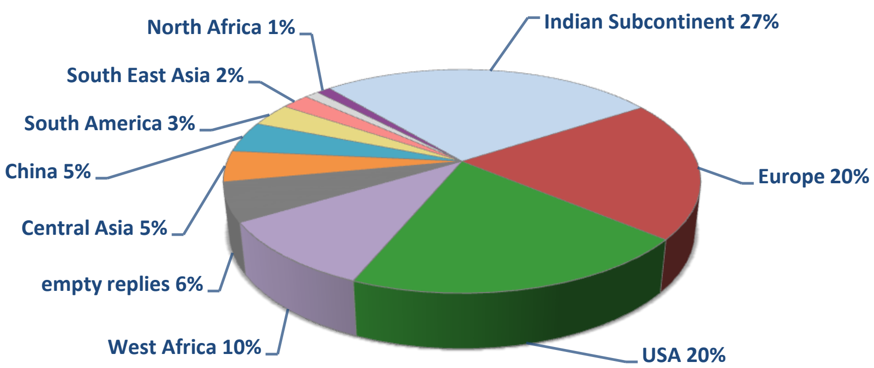

Figure 1: Overview of the origin of all respondents

Availability of Organic Cotton Seed

Organic cotton seed is difficult to access according to 81% of the respondents who considered themselves able to assess this issue. In areas where GM cotton is grown, 90% of respondents faced problems accessing organic cotton seed. In areas where only conventional cotton is grown, 40% of respondents found it difficult to access organic cotton seed.

> Commercial availability of organic seed [in the US] continues to be a major hurdle for organic cotton producers. GM seeds have become dominant in the market place as major seed companies have purchased smaller labels and discontinued their organic, non-GM and non-treated cotton seed offerings. Most survey respondents reported using at least a portion of their own saved cotton seed from year to year.
>
> *Source: Organic Cotton Production & Marketing Trends (Organic Trade Associarion, 2014)*

Three types of cotton seed are available on the market: organic, conventional (treated with chemicals or untreated) and GM (pest resistant or/and herbicide tolerant).

According to standards of organic certification, organic seeds are those that have been produced under organic cultivation (for one year for annual crops). Permission is granted (at times and for a limited period) to organic farmers to use untreated conventional seeds. On very rare occasions, permission is given for use of treated conventional seeds in organic cultivation provided the seeds are thoroughly cleaned before planting. GM seeds are prohibited in organic cultivation.

The inventory showed that about 81% of respondents found it somewhat difficult to almost impossible to access organic cotton seed, see Figure 2. Conventional seed was considered difficult to access by about 35% of respondents.

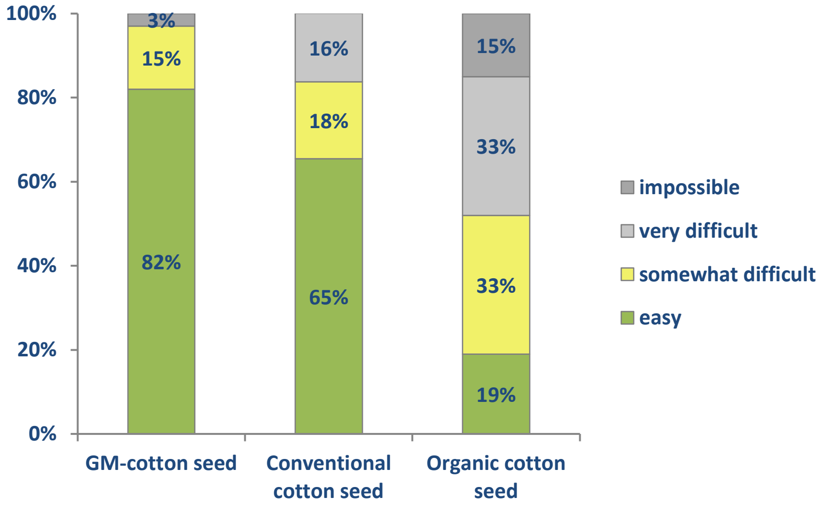

Figure 2: Opinions of all respondents on how easy or difficult access to seed is

In areas where GM cotton was widely cultivated (such as the USA, India and Burkina Faso), access to organic and conventional seed was particularly difficult; about 90% of respondents said it was very difficult to impossible to access organic cotton seed. Conventional seed also appeared to be difficult to access in those areas; 60% of respondents found it somewhat difficult to impossible to access even conventional cotton seed. Responses from China showed a mixed picture; in areas where GM cotton was grown, access to organic seed was difficult and contamination issues exist.

In areas where GM cotton was not grown, these problems were minor. In countries that have not yet allowed GM cotton to be cultivated, access to conventional seed was easy (100%), but access to organic seed remained problematic for 40% of respondents.

90% of organic farmers who responded to the questionnaire, however, felt that accessing organic cotton seed was very difficult. 73% of breeders who responded to the questionnaire found it difficult to access organic cotton seed and 50% stated it was somewhat difficult to access conventional seed.

It is clear that there is a problem in all organic cotton growing areas in accessing organic seed. Conventional seed access, particularly in countries with a ban on GM cotton, provides an escape route to organic cotton programmes. However, under certification rules, only temporary permission will be given and access to organic seed has to be established to retain organic certification.

Contamination of Organic Cotton and Cotton Seed with GM Traits or GM Seed

50% of respondents faced contamination problems with GM-traits or GM cotton. In India and the USA, contamination problems were rated high (90%-80%). In China, 67% of respondents faced problems. Countries without cultivation of GM cotton such as Turkey, Tanzania, Peru, Benin and Mali, obviously did not face contamination problems.

General questions about contamination with GM cotton were asked. The replies were a mix of problems observed with seed and with lint. The issue was considered to be fairly serious, with about 50% of respondents saying that they faced “some” to “serious” problems, see Figure 3.

Countries like Turkey, Tanzania, Peru, Benin and Mali, where GM cotton was not allowed to be cultivated, were not facing any problem with GM contamination. However, countries that are major suppliers of organic cotton (India and China plus Burkina and the USA) apparently do face problems. In India, 90% of respondents indicated that they faced some problem. 67% of respondents from China felt that they faced some problem.

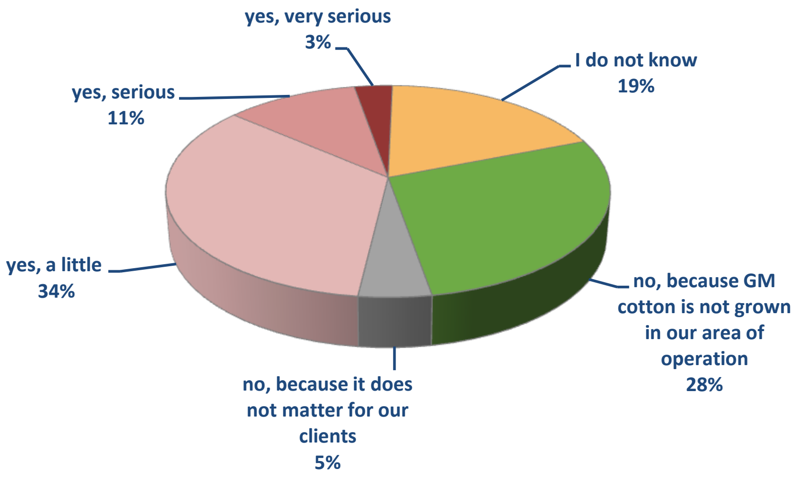

Figure 3: Opinions of all respondents on seriousness of contamination of organic cotton with GM.

Trends in Growing Organic Cotton

78% of respondents were of the opinion that organic cotton acreage will stay the same or increase, despite the problems they encounter. This was offset by the 22% of respondents who saw a decline in organic cotton area. Responses from India and China suggested that organic cotton acreage will remain stable, while responses from Kyrgyzstan, Tajikistan and West Africa suggested that acreage of organic cotton will increase. Overall, respondents from the USA saw organic cotton area expanding, although farmers themselves saw organic cotton acreage remaining stable. However, as the number of respondents was low, a final conclusion cannot be reached.

Most of the respondents (78%) were of the opinion that organic cotton acreage will stay the same or increase despite the many problems they encounter. From the responses, it can be inferred that conventional cotton is expected to decline in importance if GM cotton is allowed to be cultivated (see Figure 4).

Respondents viewed the main areas of growth in organic cotton production to be Kyrgyzstan, Tajikistan and West Africa. Close to 80% of traders were of the opinion that organic cotton area will increase. Responding farmers had a mixed opinion, equally distributed between growth, decline and stabilisation of organic cotton area.

Some respondents were of the opinion that GM cotton cultivation will decrease due to yield and profit benefits not being as good as anticipated (a result of an increase in attacks by previously minor pests).

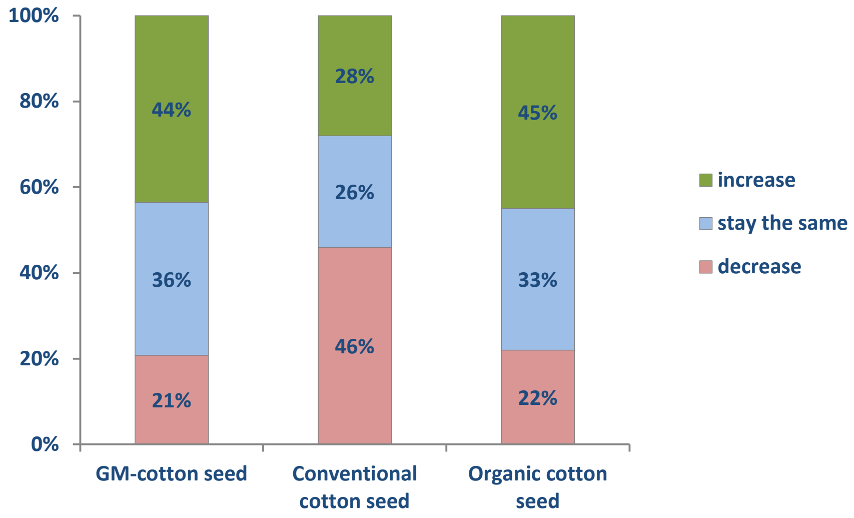

Figure 4: Opinion of all respondents on trends in organic, conventional and GM-cotton areas

> Discussions with delegates at the 2014 TE Sustainability Conference and Organic Cotton Round Table events in Portland revealed that marketing of organic cotton is problematic in Nicaragua, Paraguay and Benin. Their post ginning lint prices appeared too uncompetitive on the world market.
> This highlights the fact that not only seed is a problem, but efficiency in the organic cotton value chain as a whole should be addressed to ensure profitability of organic cotton cultivation and, thus, supply.

Profitability of Cotton Production

45% of respondents from major cotton growing areas were of the opinion that cotton acreage will decline as a result of competition from more profitable and easier to grow crops like soybean and vegetables. 22% of respondents, mostly from smaller cotton growing areas, felt that cotton growing will increase due to a more favourable policy and marketing environment.

The question was asked as to whether or not cotton is still a profitable crop to grow or whether it will be replaced by more profitable crops, resulting in a decrease in cotton growing area.

> *"Cotton area is going down, since cotton is very labour intensive and the labour costs are increasing. Therefore a lot of farmers switched to soya. Soya is a less labour intensive crop. Further, the market price for soya has increased in the past."*
>
> *Source: Respondent*

Approximately 45% of respondents predicted cotton production to decrease (see Figure 5), while 22% were of the opinion that it will increase.

The respondents who predicted that cotton area will decrease mentioned primarily soybean and vegetables as the competing crops, though at times even maize is mentioned. The main reason attributed to the decline of cotton acreage was that its profitability is under pressure as a result of rising labour and input costs, coupled with a high level of risk. Alternative crops can have a shorter growth cycle, see rising market prices, require relatively low labour input and face relatively lower risk than cotton.

Respondents with the opinion that cotton acreage was reducing originated from the USA (Texas and California), India (Maharashtra, Madhya Pradesh, Gujarat and all India), Kyrgyzstan, Mali and Peru.

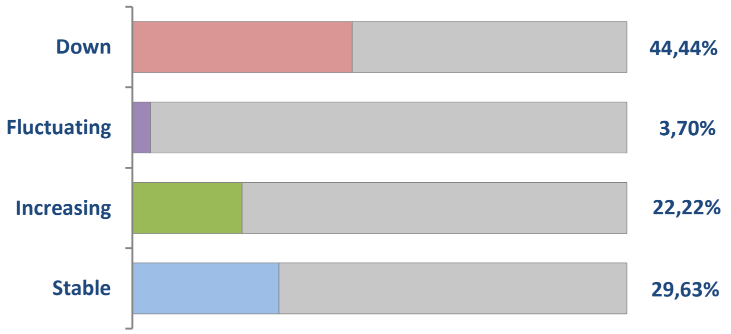

Figure 5: Opinions on whether total cotton area will increase, remain stable or decrease

> *"Cotton production has largely followed world cotton prices but with the advent of contract farming wherein farmers are getting ginners' support to grow cotton, we are seeing more land coming back to cotton."*
>
> *Source: Respondent*

Respondents who envisaged an increase in cotton area originated from Bangladesh, China, Columbia, Pakistan, Tanzania and West Africa. This suggests that the main cotton producing areas, with the exception of China, could face a decline in cotton production while areas currently producing smaller amounts of cotton could produce more cotton in the future. The argument that cotton area will increase as result of contract farming is plausible. These hypotheses will need to be verified through regional follow up workshops.

Main Factors Affecting Cotton Yields

Droughts were considered to be a very serious problem in cotton cultivation. Leaf-sucking insects were the most serious pest problem, while soil borne diseases topped the disease list. These problems need to be addressed as they cause gaps in cotton stands and increase the risks of gap-filling with GM seeds. Reduced cotton yields were found to be a result of external environmental factors beyond a farmer's control, rather than the result of factors they could control such as choice of cotton varieties, farmer practices/labour, and soil fertility management.

Table 2: Factors deemed most important in reduction of cotton yield

Factor	N	Average score (1-4)*
droughts	27	3.1
rainfall pattern	28	2.8
pests	28	2.8
diseases	26	2.5
weeds	27	2.4
onset of the rainy season	27	2.3
soil fertility	27	2.2
germination %age of seeds	26	2.2
floods	27	2.0
soil quality	27	1.8
characteristics of the variety	24	1.6
late planting because of labour shortage	27	1.5
soil depth	26	1.5
late planting because of lack of ploughing capacity	26	1.4

* 1 = no problem, 2 = sometimes a problem, 3 = important problem, 4 = very important problem

Respondents were asked which factors affect cotton yields. The replies provide a useful insight into the conditions under which cotton is grown and what conditions an ideal cotton should be able to tolerate (see Table 2). The most important characteristics were considered to be: drought tolerance, adaptation to unfavourable rainfall patterns, and tolerance to pests and disease attacks.

It is important to notice that many respondents thought cotton yield reduction was due to environmental factors that farmers cannot control rather than factors they can, for instance by choosing good varieties, improving soil fertility management and increased labour. In other words: farmers think they cannot improve their cotton growing conditions and are largely dependent on external factors. The majority of farmer respondents also indicated that they only have access to a limited number of varieties, and hence were likely to underestimate the potential of variety improvement. Moreover, without classical breeding, no GM-free varieties will be available in the long term.

The **pest complex** that farmers were facing is important for both breeding and crop management. The complex differed per continent and per sub-region in a continent. The table below only provides an insight into which pests were currently considered important and less important by the few respondents that considered themselves capable of answering the question.

It was striking that leaf sucking insects appeared to have overtaken foraging insects in order of importance. Since the number of respondents was low, the results can only be considered as a basis for a hypothesis to be verified. If verified, much work has to be done to develop organic methods to manage these pests. It might be possible that sucking pests have gained importance due to the respondents routinely using pesticides to control bollworms. An alternative explanation is that in conventional breeding programmes, pesticides are used to control sucking insects and seed selection is not focused on tolerance to these pests, whereas in organic agriculture these sucking insects cannot easily be controlled.

Table 3: Opinion of breeders and farmers on most important pests

Pest	Score (1-4)*
White fly (*Bemisia tabaci*)	3.4
Aphids (*Aphis gossypii*)	3.4
Thrips (*Thrips tabaci*)	3.4
Lygus *(Lygus vosseleri)*	3.0
American Bollworm (*Helicoverpa armigera/Heliothis*)	2.4
Semi looper (*Anomis flava*)	2.4
Jassids (*Amrasca bigutella bigutella*)	2.2
Mealy bug (*Phenacoccus solenopsis* (Tinsley))	2.0
Pink Bollworm (*Pectiniphora gossypiella*)	1.8
Spotted bollworm (*Earias vitella*)	1.8
Leaf roller (*Sylepte derogata*)	1.8
Green or brown Mirid (*Creontiades dilutus or pacificus*)	1.8
Cotton stainers	1.7
Leaf worm (*Spodoptera litura*)	1.6
Shoot weevil (*Alcidodea affaber*)	1.5
Red Bollworm (*Diparopsis castanea*)	1.4
Spiny bollworm (*Earias insulana*)	1.3

*1 = no problem, 2 = sometimes a problem, 3 = important problem, 4 = very important problem

The most **important diseases** (see Table 3) were considered to be soil borne diseases attacking root systems often in the early stages of seedling growth, leading to death of the seedling. These diseases are crucial to address as they lead to gaps which farmers fill with newly purchased seed. Gap filling could be a major factor in contamination of organic cotton with GM cotton. In conventional cotton cultivation, seed dressings with fungicides are used. In organic farming, dressings with *Trichoderma spp*, *Bacillus similis*, *Pseudomonas spp.* could offer relief. Breeding for resistance or tolerance could offer a solution, but that would take time.

Respondents from China and Kyrgyzstan were of the opinion that diseases were more important than pests. Strikingly, the respondents answered that all of their cotton was full-season irrigated. This suggests that there might be an interaction between irrigation and disease. Over-irrigation could be an important cause, but this hypothesis would have to be verified at the local level.

The "Ideal" Cotton Variety

The ideal cotton as described by the respondents is a utopian one. It probably cannot be realised as the criteria given are in conflict. It is required that further priority ranking of breeding/selection criteria is defined in sub-regions.

Respondents were asked to describe the ideal cotton with the purpose to be able to derive selection and breeding criteria. From the responses given by those who considered themselves able to characterise the ideal cotton, the ideal cotton plant can be described as follows:

- short to medium in duration
- many branches
- short to medium flowering period
- many bolls sitting in the upper part of the plant
- with long fibre
- medium plant height
- quite open

In addition, it should be **drought tolerant**, able **to resist/tolerate attacks by sucking insect**s and **resistant or tolerant to soil borne diseases**.

Which Characteristics Should Fibre Have in 2025?

Retailers were asked to give their opinion on changes in the retail market: what kind of products will increase or decrease in volume in 2025 compared with present day markets? The result is presented in Figure 6. The information presented in Table 4 was used to arrive at the implications of this change in volumes for the required staple length.

Although changes cannot be quantified in terms of the extra kilograms of lint required of one or another staple length, the conclusion is that most additional demand will be in the medium to long staple length with a small niche developing in the extra-long staple market.

Table 4: Linking fabric, yarn count and staple length

Products	yarn count Ne	Staple length (mm)
Twill pants	20	24
Tee shirts:	20-40	24-29
Heavy shirt	30	28-29
Light pants	30	28-29
Bed Sheets	40-80	29-34
Denim	4-12.5	<24
Softer chambrays	12.5-30	25-29
Towels	40-100	29-35
Dress shirts	50-140	32-38
Lawn for summer blouses	>50	> 32
Chiffon and Voile	>100	>35

Source: personal communication Jeff Wilson, TE and Mani Chinnaswamy, Appachi Cotton, 2014/2015

This has implications for seed and breeding programmes: there seemed no need to supply seeds with increased staple length. Farmers would like to produce higher staple length cotton as it will fetch higher prices. However, the reality is that already many spinners are forced to underspin the lint they have bought, resulting in higher prices for lower count yarn. This might put pressure on the prices paid for 30-32mm staple cotton. Shorter staple cotton is going to be scarce on the market, hence prices might increase. Farmers usually will face less risk when producing shorter staple cotton. A best guess would be that the bulk of lint required would be having a staple length of 28 to 29mm. This needs to be verified in regional workshops.

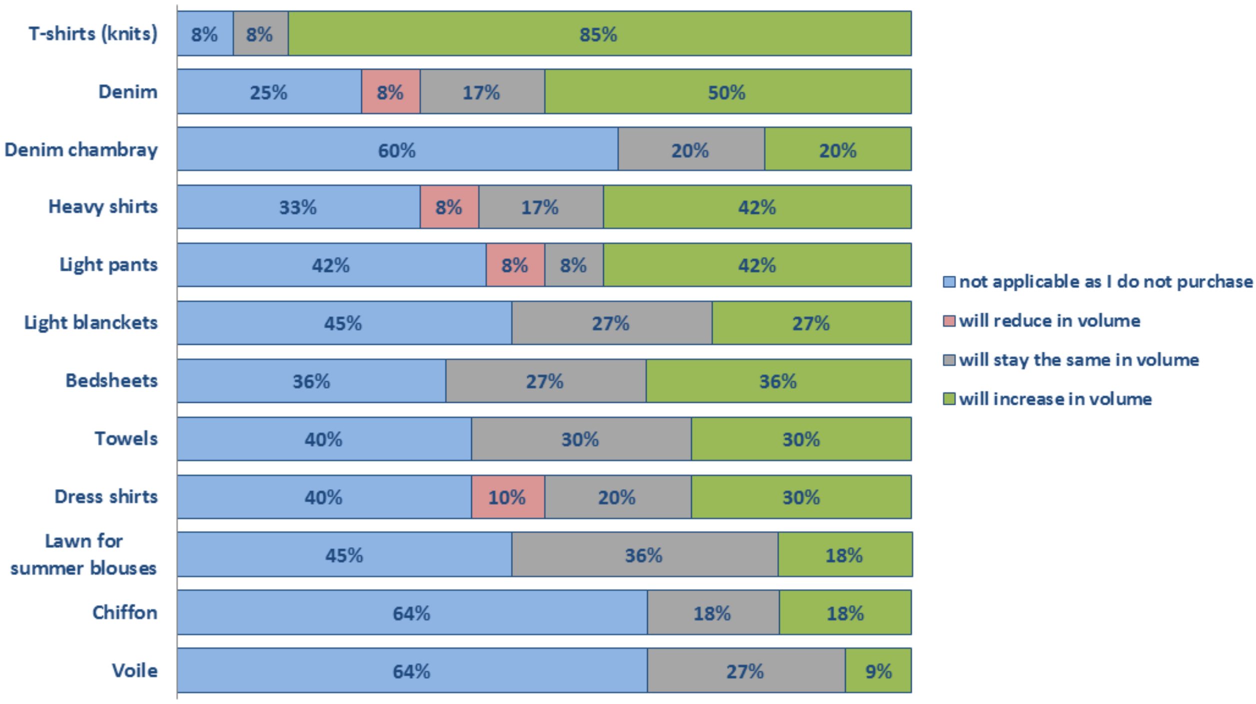

Figure 6: Expected changes in volumes of purchased finished products by 2025 compared with 2014

It appeared, though, that a specialty market is foreseen for 32-38mm staple cotton products: dress shirts. The specialty market could also include fine bed sheets and high quality towels, but this needs to be investigated further. Tajikistan is emerging as a strong candidate for this sub-sector (TE Organic Cotton Report 2013). An additional advantage for the organic cotton sector is that Tajikistan will probably remain a GM-free country (source: questionnaire respondent).

Importance of Seed Programmes

Development of seed programmes was considered important to 95% of respondents. The respondents had a slight preference for seed multiplication programmes for certified non-GM seed. Variety selection and breeding followed at a very close second. Respondents from the USA, West Africa and China had similar opinions. In India, seed multiplication programmes for organic seed were preferred, followed by breeding programmes to develop new non-GM cotton varieties.

Respondents were asked their opinion on the importance of developing seed programmes to improve availability of non-GM cotton seed or organic cotton seed. An overwhelming 95% of respondents felt that it was important to very important to develop seed programmes (see Figure 7).

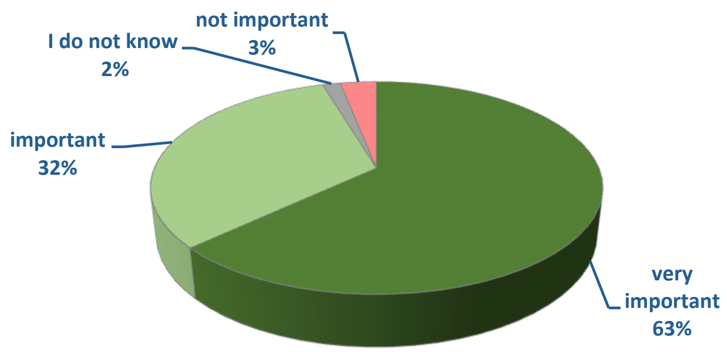

Figure 7: Importance of seed programmes

Also asked were questions on the type of seed programme that was envisaged by respondents. Full freedom was given to answer in all categories and Figure 8 presents the results. It can be seen that seed multiplication programmes were slightly preferred, followed closely by variety selection programmes and breeding programmes. Looking at the answers of respondents from different regions it was found that, with the exception of Indian respondents, respondents from all regions had similar preferences.

The Indian respondents gave more importance to organic seed multiplication and breeding programmes as can be seen in Figure 9. This might be influenced by the fact that some breeding programmes for low-input conditions are already implemented in India.

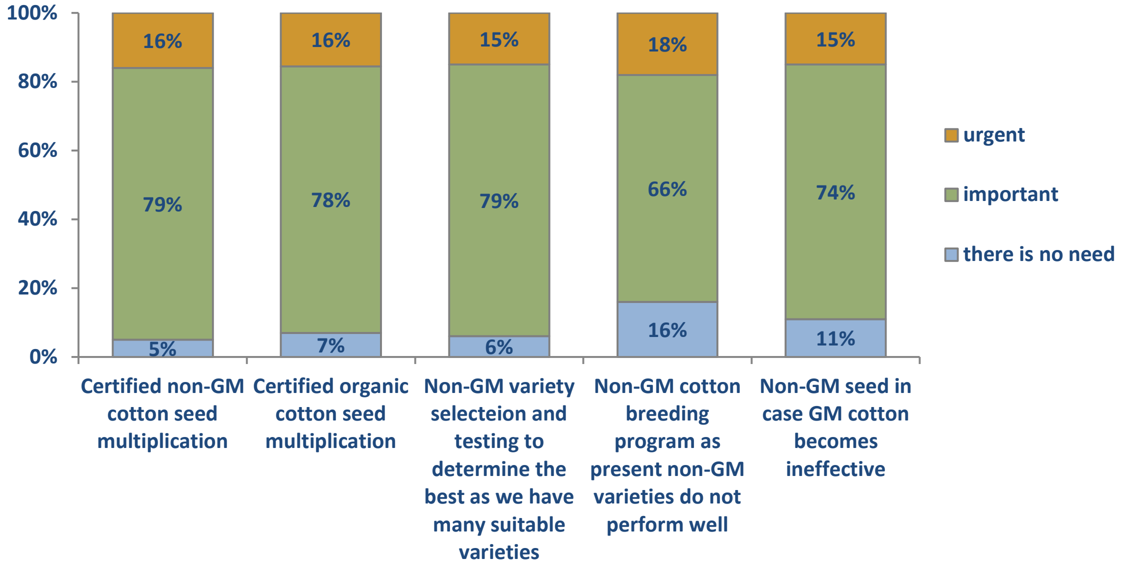

Figure 8: Preferred type of seed programmes (all respondents)

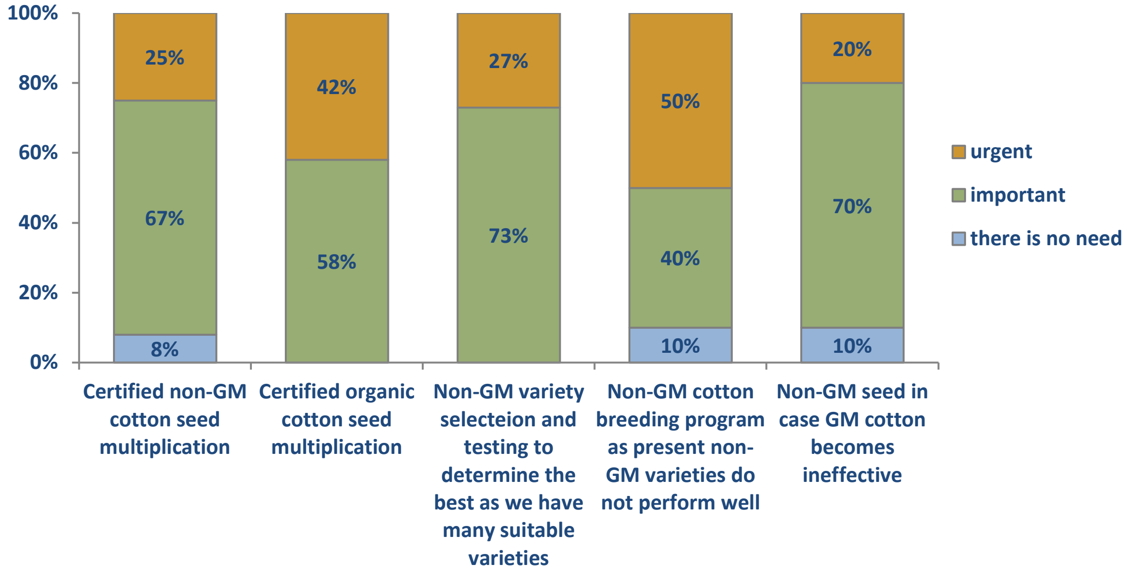

Figure 9: Preferred type of seed programmes in India

3 Discussion

In this section, the outcomes of the questionnaire are discussed to provide a clearer picture and better guidelines for a future strategy to be developed.

From answers to the questionnaire, it became clear that access to organic and even conventional, non-GM seed was difficult in most countries and exceptionally difficult in countries where GM cotton is allowed to be grown. Most of the organic cotton originates from countries where GM cotton is also grown: India (75%) and China (10%). In such countries where GM cotton is grown contamination of organic cotton with GM cotton was considered a substantial problem. Almost all respondents (95%) were of the opinion that seed programmes are required for the organic cotton sector. Most respondents had a slight preference for seed programmes that produce certified non-GM seed. However, breeding programmes to improve varieties to better adapt to organic and low-input growing conditions were considered almost equally important.

Short term and long term goals

When developing a strategy for seed programmes it is important to look critically at the entire cotton sector of an area before embarking on a seed program. Such programmes can have both a short and long term goal. The short term goal is the production of non-GM seed. The long term goal is the breeding of GM-free varieties. Without a breeding program, it will be difficult to guarantee the availability of better-adapted, good GM-free varieties in the future. As growing conditions change, the continuous development of well-adapted varieties is crucial. The importance is underlined by the current changes in climate worldwide.

Region specific approach required

Based on the questionnaire, observation and the TE Organic Cotton Market Report 2013, cotton production appears to be under pressure from easier to grow and financially competitive crops like soy. This seems to be an issue particularly in India, which produces 73% of the world's organic cotton. According to the results of the questionnaire, contamination with GM cotton was considered as substantial in India as well. It is, therefore, important to analyse the risk that farmers will stop cotton production or that organic cotton buyers will avoid countries with high levels of contamination like India. In answer to specific questions, some farmers indicated that they are contemplating stopping cotton growing. When companies have been asked whether they are considering shifting their sourcing of organic cotton some indicated they were thinking of it while others have not (yet) considered it.

Based on common knowledge, each region faces specific issues and these should be addressed individually. West Africa faces problems with competitiveness of their fibre prices on the world market plus the lack of processing capacity beyond ginning (which itself has over-capacity). East Africa sees rapid development (especially in Tanzania and Ethiopia) of the cotton sector as a whole, including processing. Turkey has an advantage of having a strong and developed non-GM cotton sector, but organic farmers have difficulties in attaining the yield levels of conventional farmers, particularly in the early years of transitioning to organic agriculture from chemical based production. China has a well-developed GM cotton sector but increasing labour costs might affect the long term competitiveness of the market. North and South America are facing GM-issues and also issues with competitiveness of their cotton on the world market due to production costs.

When regional seed strategies are developed, these issues need to be verified, tackled or at least be taken into consideration.

Seed supplies differ

Throughout the world, different systems of cotton seed supply are in use. Some countries, like India and Southern Africa, have completely commercial seed companies that supply farmers with cotton seed against direct cash payment. Others, such as the French speaking West Africa, have government managed seed systems that provide farmers (subsidised) cotton seed on credit which is paid by farmers when they trade their cotton through the government controlled gins.

Often gins play an important part in seed distribution to farmers. They (mostly) provide farmers with seed bought from seed companies but, at times, also sell seed directly obtained from ginning to farmers. In the organic cotton sector, the role of seed supply is often assumed by Non-Governmental Development Organisations (NGDOs) supporting organic cotton farmers. At times, the NGDO place indents with seed companies on behalf of farmers (e.g. Chetna Organic in India). They might also help farmers to access foundation seed from research institutions for multiplication by selected members (e.g. RECOLTE but also Chetna Organic).

Before embarking on a seed strategy and implementing it, a clear understanding of the supply system is required. In the case of India, this study has been made by Laura Marty (2013). The basic issue is that organic cotton constitutes only 1% of the cotton area worldwide. Production areas are often scattered over a country and, thus, the problem of sufficient purchase volume arises. Seed companies see it as a burden to produce organic cotton seed, especially in countries where GM cotton is dominant. The only reason for them to continue to multiply non-GM cotton is the legal requirement in some, but not all, countries to provide non-GM cotton seed for a refuge zone (usually 20% of cropped GM area). However, in many countries it is now accepted that other crops can be used as refuge. This completely takes away the incentive to multiply non-GM cotton seed.

Contamination

The contamination issue is only relevant in countries where GM cotton is grown. Often it is thought that contamination with GM cotton is caused by cross-pollination. However, there are more important sources of contamination to look into. Flowers of many cotton varieties are self-fertile and self-pollinating. Cross pollination is, consequently, very limited, see e.g. OSGATA (2014). More probable is the contamination at the ginner's site and that seeds planted by farmers are GM seeds. The main reasons for unintentional planting of GM seeds are: farmers purchase cheap seed from ginning mills who do not carefully segregate organic, conventional and GM seed. Or farmers need to fill gaps in their fields and purchase any seed available which is, in areas where GM–cotton is grown, mostly GM seed. See for further explanation in Annex 1.

Open pollinated varieties are more at risk of getting contaminated than hybrid varieties. The reason is that open pollinated variety seeds are recycled from one season into the other through the ginner, who probably does not see himself as the entity that has to safeguard against mixing GM and organic seed. If the ginner does not separate the seeds well and seed companies purchase seed for de-linting and packing from him, then risk of contamination is high.
Hybrids are generally produced by reputable seed companies under close supervision, therefore there should be fewer problems with contamination if the companies adhere to established procedures of quality control. They often outsource seed multiplication to specialised farmers who

should be regularly inspected. To what extent this really happens depends on the seed system and quality control system in a country.

However, it is possible that poor farmers purchase segregating F2 hybrid seed back from ginners. In such a case the risk of contamination of organic cotton seed with GM seed is high. Farmers do this because the price of this seed is about 20% to 50% of the proper first generation (F1) hybrid seed. This leads to considerable savings in production costs, but also in higher variability of the quality of the lint and lower yields. The risk of getting GM seeds mixed with seed that is purchased as organic depends on how seriously the ginner keeps the organic and GM seed separate.

The ginner plays an important role in keeping organic but also conventional seed free from GM seed. In some countries, they are legally required to do so. In other countries the law does not prescribe this. Enforcement of the law is a separate issue.

Need for improved crop management at farm level for better profitability

The results of the questionnaire indicated that cotton production as a whole is under pressure. Easier to grow crops with a shorter growth cycle, demanding less labour and investments while giving good returns, are putting on the pressure. Climate change, resulting in excessive rains followed by extended periods of drought, can also be blamed. The fact that many respondents felt that droughts were a major limiting factor in cotton production supports this opinion.

Cotton picking in India is done by hand. A worker who is presently paid about INR 300 a day can pick at most 30kg. Present prices for raw cotton are about INR 30 per kg thus harvesting alone absorbs 30% of the income earned. Doubling the volume of bolls that can be picked per day would substantially increase profits.

Source: Personal communication, M. Lanting, 2014.

It is thus imperative to make cotton a more attractive crop to grow. Field level experience of the task force members indicates that labour costs of weeding and picking are high; they can constitute more than 50% of the costs of production. TE should, therefore, also pay attention to stimulating members to look into technologies that can increase the productivity of labour used in cotton growing.

Yields of organic cotton are notoriously low. This could be caused by sub-standard crop management due to lack of access to money or a lack of technical knowledge on the part of the farmers. Improved soil, nutrient and pest management techniques need to be imparted to farmers to improve profitability.

Programmes to improve water retention in the landscape and provide water for emergency irrigation of cotton require all possible support to alleviate the effects of climate change.

Breeding goals and priorities

The respondents described their ideal cotton variety. However, currently, this idea is “utopian” and non-achievable, and therefore priorities have to be set.

First, it is important to develop varieties specifically for organic cultivation as nutrient and pest-disease management in organic cotton differ substantially from conventional production methods of cotton. As organic farmers largely depend on conventionally bred varieties, it is logical that varieties used by some organic farmers are not optimally suited for organic cultivation. They have been selected and bred mostly under optimal conventional growing conditions (using irrigation, frequent pesticide applications and high amount of readily available fertiliser) and for the conventional method of cotton cultivation.

The biggest difference between organic and conventional cultivation methods is found in nitrogen management options available in organic farming compared with the easy application of nitrogen fertilisers in conventional cotton production. Selection criteria should be focusing more on symbiosis with a large number of bio-agents (e.g. Mycorrhiza, Phosphor Solubilizing Bacteria, etc.). Pest and disease management also differ, requiring to breed more for morphological traits (like hairiness) to make plants less attractive to leaf sucking insects or egg laying. Suitability of the cotton variety (developed under an organic breeding program) for mixed cropping should be taken into consideration as crops like pulses will be intercropped for various purposes. The conventional systems breed cotton for monocropping.

Secondly, there are issues on the morphology of cotton and the way it grows. This will clarify why the “ideal” cotton variety cannot be bred.

Cotton is developing flowers and thus bolls bottom upwards (see Figure 10). Therefore, demanding a cotton variety with bolls in the upper part and of medium duration is very problematic as top bolls will mature about a month later than first bolls.

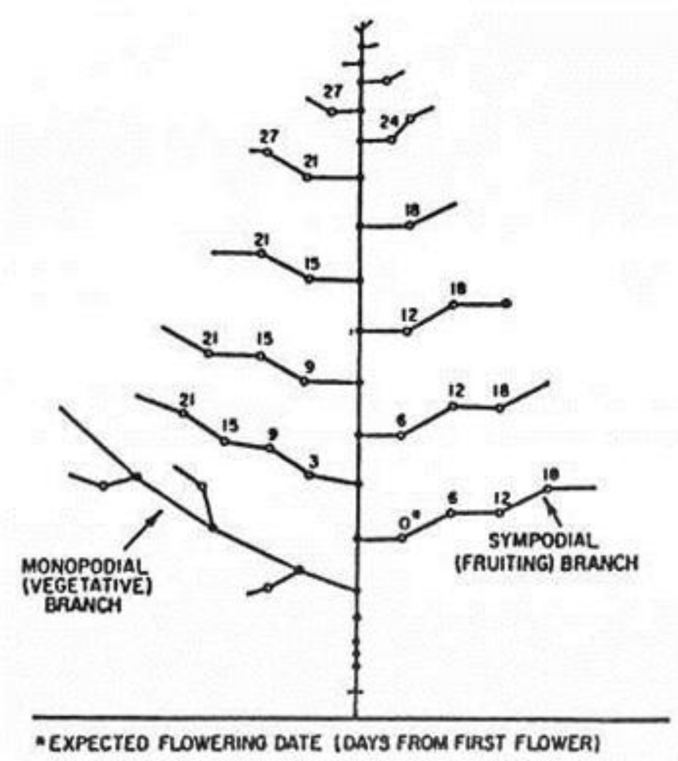

Figure 10: Flowering pattern of cotton. (Source: Oosterhuis, 1990)

GM cotton ensures retention of the early bolls which means that farmers often complain about having to pick bolls very low on the plant. In organic farming, often due to inappropriate pest management, early bolls drop and harvest takes place from the middle of the cotton plant, but the fibre is shorter and the yields are lower. Top of the plant bolls are often exposed to end of season, thus unfavourable weather conditions, leading to poor quality cotton (immature, shorter staple length, low uniformity).

There are various trade-offs, in particular:

- Earliness and number of branches and bolls: more bolls requires more branches and thus a longer growth cycle.
- Number of branches and openness of the plant: more branches decrease openness of the plant.
- Fibre length and number of bolls: fewer bolls lead to longer fibre and more bolls to shorter fibre so demanding both more bolls and longer fibre is conflicting.

Clearly, further discussion is required with farmers in the various regions to ascertain the priorities in the list of demands and to discuss what are realistic demands that can be met relatively easy through selection or breeding, see e.g. studies in Uganda by Preissel (2011) and Van Dijk (2014).

4 Conclusions and Recommendations

This internet-based inventory, compiled using the results of a questionnaire distributed to Textile Exchange's networks, has provided the first overview of global and region-specific organic cotton seed availability. Also explored were contamination issues, problems and trends in cotton production, and opinions on the variety characteristics required to meet future demands. It is important to keep in mind that the number of respondents per continent was too low to arrive at solid and statistically sound conclusions, but sufficient to give a first global overview of the main seed issues. This report has formulated hypotheses that should be checked against reality in regional workshops.

Key findings:

- **Organic cotton seed is difficult to access according to 81% of respondents.** In areas where GM cotton is grown, 90% of respondents faced problems accessing organic cotton seed, whilst in areas where only conventional cotton is grown, 40% of respondents found it difficult to access.

- **Contamination problems with GM cotton were experienced by 50% of respondents.** Those producing organic cotton in countries where GM cotton production is prohibited do not face contamination problems. From the questionnaire, Turkey and Tanzania seemed the only major organic cotton producers that do not (yet) face any problems with contamination.

- **Most respondents point at cross pollination as the major cause of contamination.** However, research carried out in Burkina Faso and the USA points at seed purchased for planting as the major pathway for contamination of organic cotton. Other possible pathways are analysed in the report. Ginning factories appear to act as ''guardians'' of pure organic seed.

- **Cotton, as a crop, is under pressure from easier to grow and more profitable alternative crops such as soybean.** About 45% of respondents think that cotton areas might reduce. It is worrying that these originate from major cotton producing countries such as India and the USA. Chinese respondents feel that their cotton area will expand, as do a number of other, presently smaller, cotton producing countries.

- **Many of the respondents who felt able to describe the ''ideal cotton'' thought that the staple length of cotton should increase to "long".** Retailers and wholesalers, however, predicted that the market for t-shirts will drastically increase and these would probably not require much longer staple length than 29mm.

- **The "ideal cotton" described by respondents is a utopian one.** It cannot be achieved since the desired criteria are contradictory. There also appears to be a mismatch between the diseases and pests that breeders focus on in their breeding programmes and those that were prioritised by respondents as the biggest production constraints. Further priority rankings of breeding/selection criteria will need to be defined in each sub-region.

Recommendations

Steps should be taken at a regional level to safeguard the integrity of organic cotton and support the availability of organic, non-GM seed as the basis of the organic cotton production chain.

Suggested actions:

- **Immediate:** Regional workshops should be initiated with an emphasis on India, China and West Africa to further specify the needs and explore feasible steps forward.
- **Short term:** seed multiplication programmes should be established where it is difficult or, in some regions, even impossible to source organic seed.
- **Long term:** seed breeding programmes should be developed to improve and better adapt cotton varieties to organic and low-input growing conditions.

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Annex 1. Contamination of GM cotton

Figure A1: Bee foraging on cotton flower

Contamination of organic seed with GM seed or with traits of GM can happen through accidental mixing of seeds of both origins or through cross pollination.

Although limited, cross pollination happens when pollen of GM cotton fertilises the stigma (female part) of the flower of a nearby organic cotton plant. The chances for this to happen are slim as the pollen of cotton is heavy and cannot easily be carried by wind from one flower to the other. For the same reason insects, carrying the pollen from one flower to the other, need to be relatively large.

Figure A2: Beetle important in cotton pollination

Bees (Figure A1) are excellent pollinators of cotton and have been found to carry cotton pollen over a distance of 800 meters. Also beetles (Figure A2) crawling from one plant to the other are important pollinators of cotton. The maximum distance they carry pollen has been found to be about 50 meters. The more insects present, the larger the chance that cross-pollination takes place.

Cross pollination is estimated to be accountable for about 1% of the contamination of organic cotton (Heuberger et al., 2010; OSGATA, 2014; Vognan & Bourgou, 2014).

It is more probable that the seed planted is contaminated. (1) Seed purchased as organic seed is not always free of GM. For example, farmers may purchase cheap seed from gins that is contaminated, or the seed may become contaminated elsewhere in the supply chain. Or (2) Farmers have to fill gaps in their fields when drought or floods have led to irregular stand. Due to shortage of organic seeds, they might just buy whatever is available on the market, which is, in many cases, GM cotton seed.

Noted below are two different methods of seed multiplication and the contamination risk for each of these methods.

Once breeding has resulted in new, marketable varieties and seed multiplication is required, open pollinated cotton fertilises its flowers in a completely natural way, no specific activity is undertaken by humans to pollinate the flowers. Farmers can use the seed that remains after ginning for the next season. However after some years (3 to 6 years) they will have to replace the seed with new seed from a seed company to ensure proper characteristics.

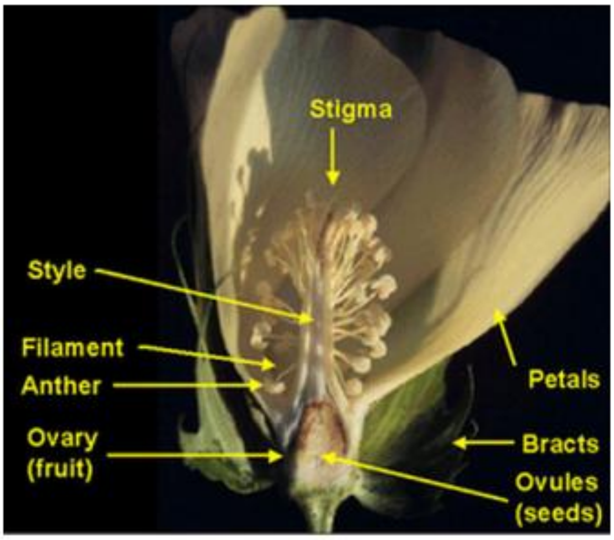

Figure A3: Cross section of a cotton flower

Hybrid seeds are produced by pollinating one variety (maternal line), from which the anthers (that produce pollen "semen") have been removed (see Figure A3) so only the female part (stigma) is left, with the pollen of another variety (paternal line). The effect of hybridisation is that the yield of the first generation is higher than that of each parental line. The genetic uniformity of that first generation is high. Second, third and fourth generations show lower yields and an increasing variability (staple length, micronaire, maturity start to differ between individual plants). That is why farmers need to replace hybrid seed - preferably every year.

If all is well, breeder and foundation seed is NOT contaminated. The parent lines need to be maintained at least 400 meters away from GM cotton (on all sides) according to seed laws in California. Many seed companies are expected to face problems in maintaining this isolation distance, especially when they are also producing GM cotton seed and are located in densely populated areas.

> *Removing GM traits from contaminated cotton varieties to be used as breeder seed and parent lines is an expensive proposition. It can cost anywhere between $15,000 and $500,000 USD as many steps are involved.*
>
> *Source: Jane Dever, Texas A&M – AgriLife Research, personal communication, 2014*

There is some indication from the half yearly report on RECOLTE that foundation seed in Burkina might not be GM-free (Quemore & Bangre, 2014).

> *"…isolation distances required between 'similar' cotton types of the same species for foundation or registered cotton seed production in California are 660 feet plus 20 feet of buffer rows if there is no intervening cotton field. 'Widely different' cotton types require separation of 1,320 feet plus 20 feet of buffer rows for foundation and registered seed."*
>
> *Source: Robert B. Hutmacher et al. , 2006*

From the flow-diagram presented above (Figure A4), it can be concluded that open pollinated varieties are more at risk of getting contaminated than hybrid varieties. The reason is that open pollinated variety seeds are recycled from one season into the other through the ginner, who probably does not see himself as the entity that has to safeguard against mixing GM and organic seed. If the ginner does not separate the seeds well and seed companies purchase seed for de-linting and packing from him, then risk of contamination is high.

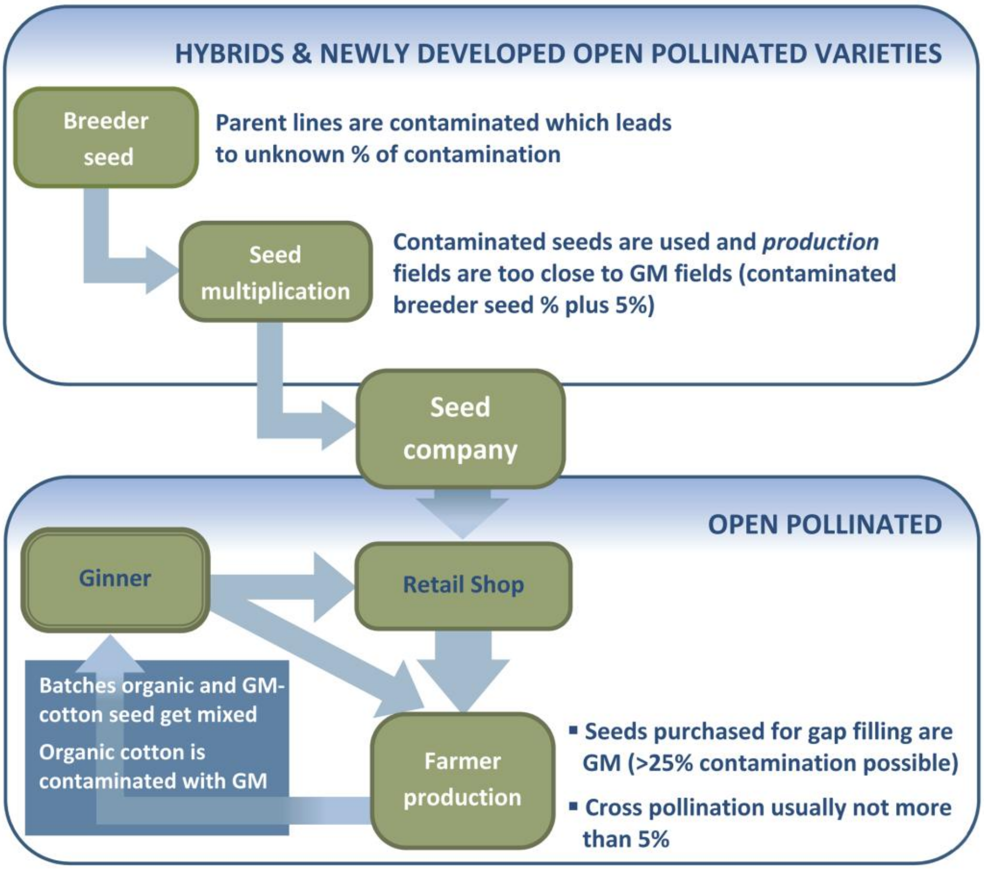

Figure A4: Flow diagram of possible sources of contamination

> *L'analyse du maillon « semence » montre que la semence fournie aux producteurs de coton bio pour la production s'est révélée assez contaminée au moment de la livraison. Pour le peu d'échantillons que nous avons analysé, le taux de contamination est élevé, étant donné que la semence est la base de toute production. (Analysis of the seed sample taken shows that the seed provided to organic cotton producers is contaminated at the moment of delivery. For the limited samples we analysed the level of contamination is considered high given the fact that seed is the base of all production)*
>
> *Source: Vognan & Bourgou, 2014.*

> "Although **seed-mediated gene flow** has received less attention than pollen-mediated gene flow in the literature, it was clearly the most prominent source of cry1Ac transgene flow in this study…"
>
> Source: Heuberger et al., 2010.

…"Absolutely uncontrollable, we need separate gins and delinters.."…"0% contamination is no longer possible"…

Source: respondent to this questionnaire when asked ''do you face contamination problems?''

Hybrids are generally produced by reputable seed companies under close supervision, therefore there should be fewer problems with contamination if the companies adhere to established procedures of quality control. They often outsource seed multiplication to specialised farmers who should be regularly inspected. To what extent this really happens depends on the seed system and quality control system in a country.

However, it is possible that poor farmers purchase segregating F2 hybrid seed back from ginners. In such a case the risk of contamination of organic cotton seed with GM seed is high. Farmers do this because the price of this seed is about 20% to 50% of the proper first generation (F1) hybrid seed. This leads to considerable savings in production costs, but also in higher variability of the quality of the lint and lower yields. The risk of getting GM seeds missed with seed that is purchased as organic depends on how seriously the ginner keeps the organic and GM seed separate.

The ginner plays an important role in keeping organic but also conventional seed free from GM seed. In some countries, they are legally required to do so. In other countries the law does not prescribe this. Enforcement of the law is a separate issue.

"Results from this study suggest that crop spacing can be used to limit unwanted gene flow, as Bt cotton fields >750 m from the edge of monitored fields did not appear to contribute to outcrossing. However, pollen-mediated transgene flow rates were always low in this study (i.e., <1% of seeds at the field edge), even in monitored fields that were near Bt cotton fields. This suggests that spacing fields hundreds of meters from transgenic crops is unnecessary for cotton, even in the European Union where the labeling threshold for adventitious presence in crops is 0.9%. However, this study demonstrates the potential for seed-mediated gene flow to become prominent in settings where actions are not taken to keep adventitious presence in check. […….]

In settings where seed purity is desirable, seed producers and decision makers should consider:
1) screening seeds to monitor adventitious presence in the seed supply, and
2) communicating the importance of segregating seed types at planting to reduce human error."

Source: Heuberger et al., 2010